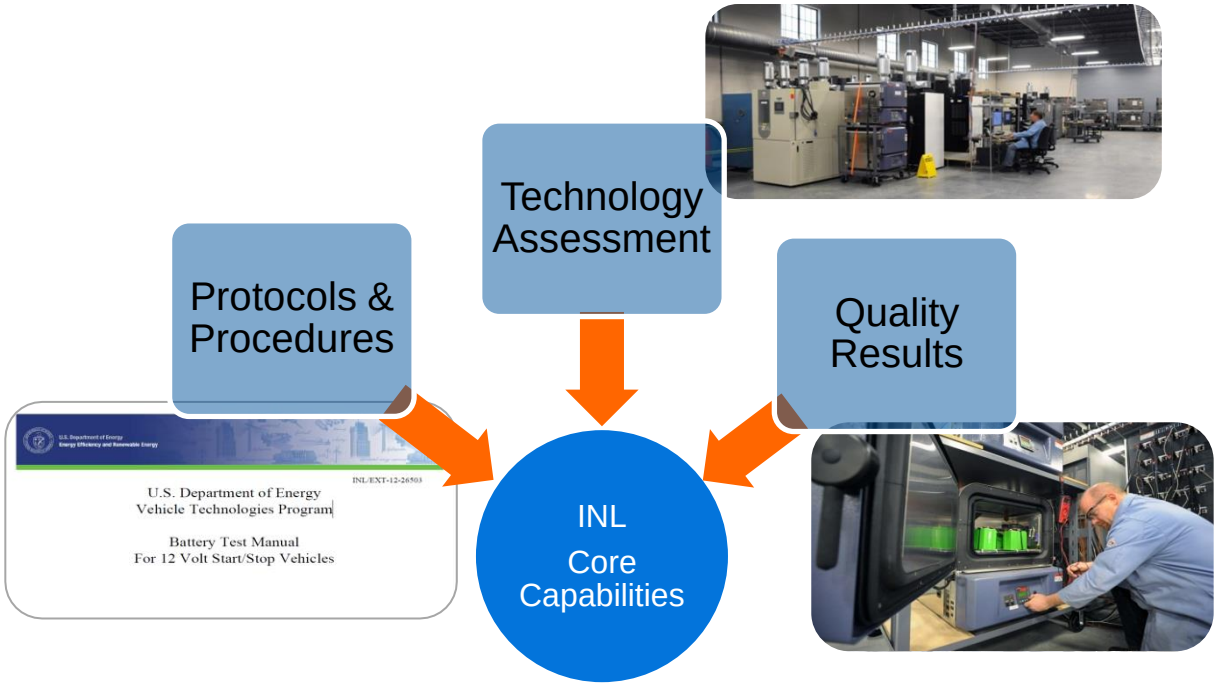
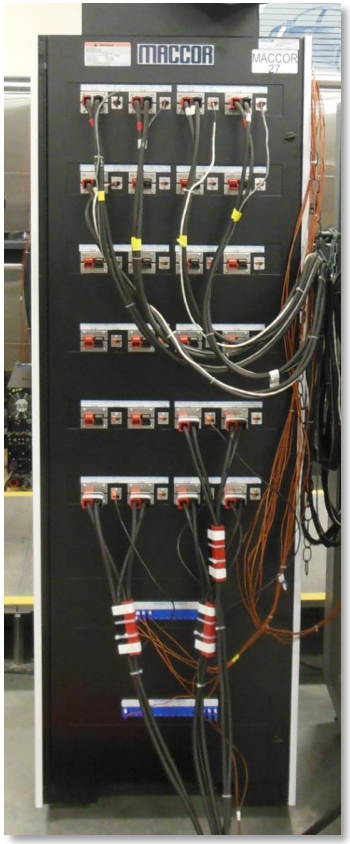
TESTER PROGRAMMING



Randy Bewley

Types of tester



Types of tester

- **Maccor - Tabular style**

C:\Battery Lab\T2M WORKSHOP\EXAMP-STCC1.000

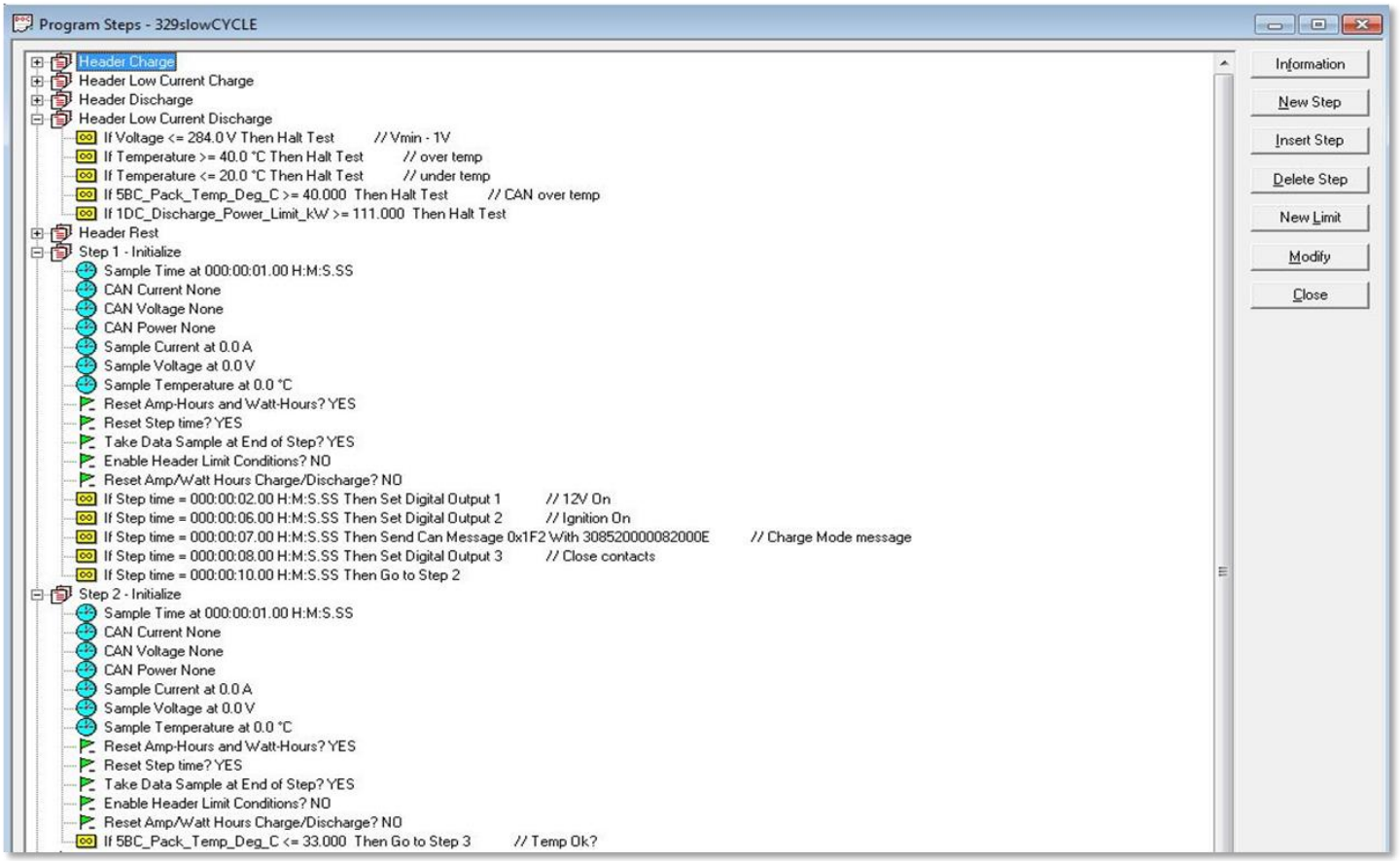
Description

Typical static capacity test. Vmax=14.6V, Vmin = 10V, C1=40A.

Step	Type	Mode	Value	Limit	Value	End Type	Op	Value	Goto	Report Type	Value	Options	Step Note (80 character maximum)
1	**Rest**					**Step Time**	**=**	**00:00:10**	**002**	**Step Time**	**00:00:01**	**ANNN**	**10 points**
2	**Rest**					**Thermocouple**	**>=**	**1 / 27.0**	**003**			**ANNN**	**temp correct?**
3	**Rest**					**Thermocouple**	**<=**	**1 / 33.0**	**004**			**ANNN**	**temp correct?**
4	Do1												
5	Advance Cycle												
6	Rest					Step Time	=	00:00:01	008			ANNN	
7	Pause												
8	Charge	Current	20.0	Voltage	14.7	Voltage	>=	14.6	010	Step Time	00:01:00	ANNN	Constant current charge
						Step Time	=	02:00:00	010				
						Voltage	-	0.3	007				
						Thermocouple	>=	1 / 40.0	007				
						Thermocouple	>=	2 / 33.0	007				
						Voltage	<=	10.0	007				
						Thermocouple	<=	1 / 20.0	007				
						Thermocouple	<=	2 / 37.0	007				

Types of tester

- **Bitrode – Conversational**



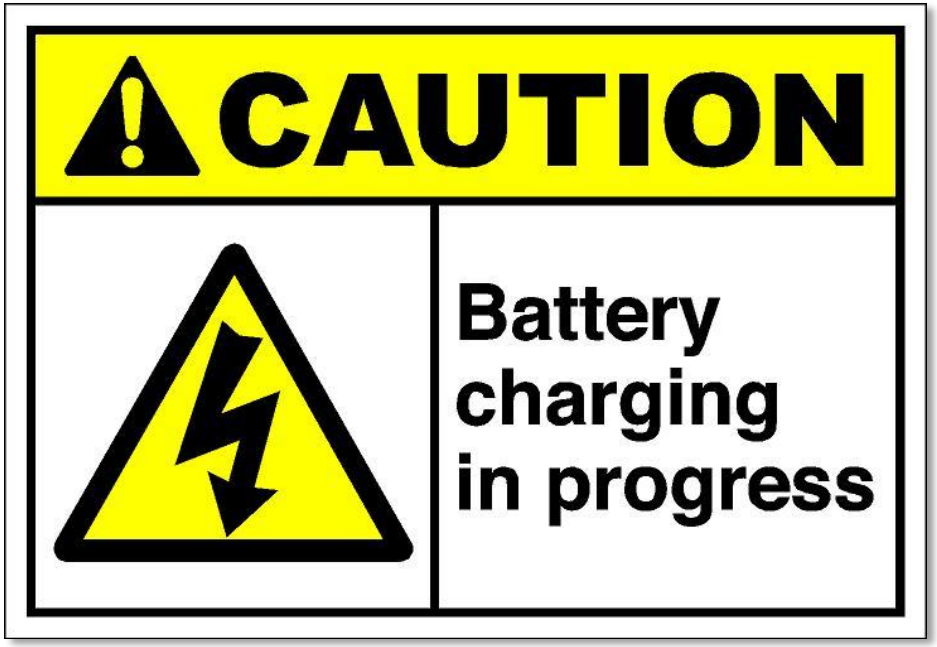
Types of tester

- **Energy Systems – Text (If-then)**

C:\Battery Lab\T2M WORKSHOP\P327Cal30.tpf

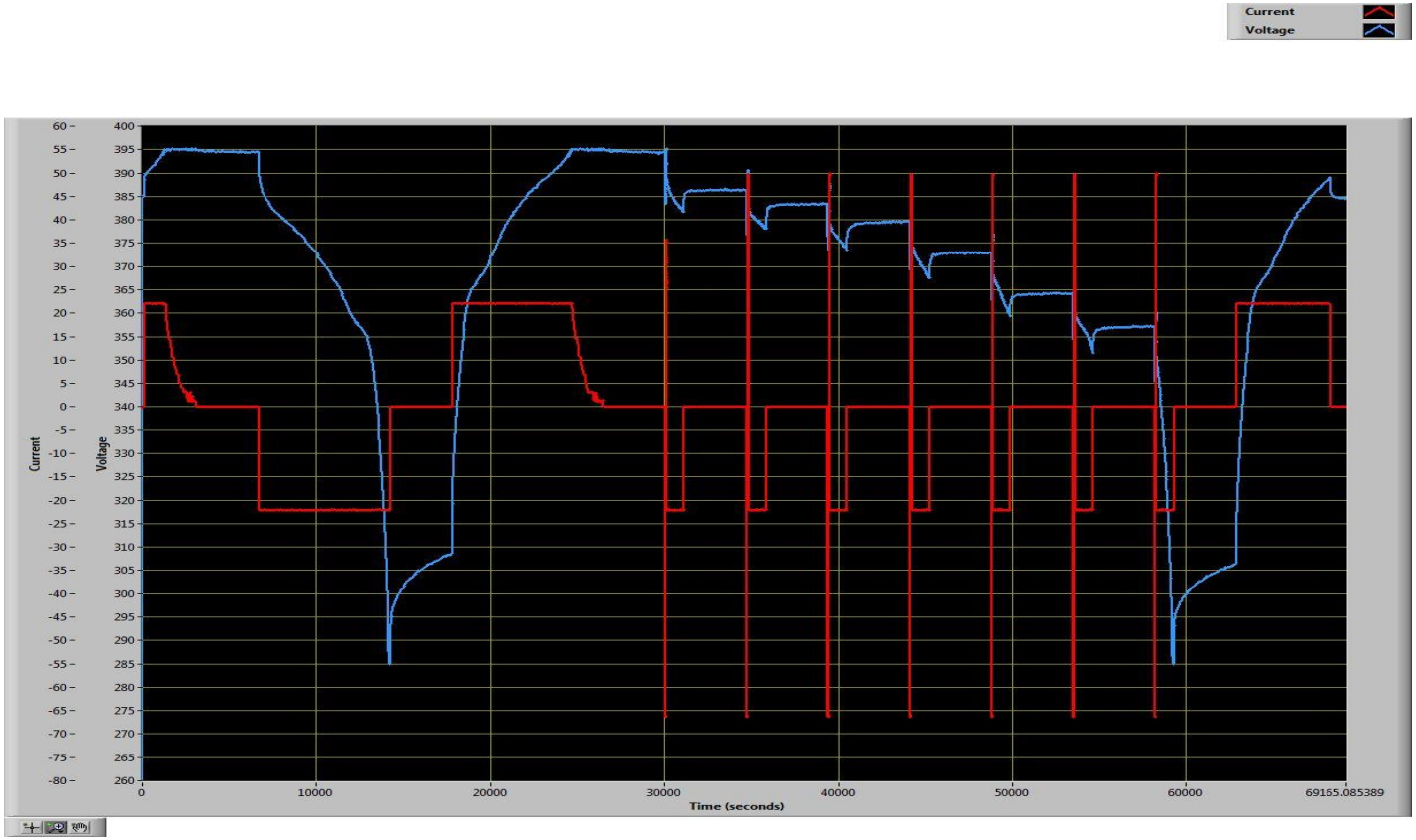
```
#<><><><><><><><><><><><><><><><><><><><><><><><>< Charging Steps ><><><><><><><><><><><><><><><><><><><><><><><><><><>
#<><><><><><><><><><><><><><><><><><><><><><><><>< Charging Steps ><><><><><><><><><><><><><><><><><><><><><><><><><><>

#                          < start constant current charge  >                                              <step #6>

step step_charge  # < start charge sequence (constant current to ~100% SOC 398.4v) >

+10000w +chg_C1 a +405.0 v                        # 15a to 398.4v
   net_amp_flag = 1                               # start adding net amp secs and watt secs
   sample_interval = 60                           # one point a minute
   step_status = ' 15A charge to 398.4 volts '
        if step_time >= 9000 then                 # if 2.5 hours accrues in seconds
                net_amp_flag = 0                  # stop adding amp secs
                record_data                       # record data when event happens
                step = charge_rest                # jump to charge rest <step 9>
        end
        if smooth_voltage >= chg_vlimit then      # jump next at 398.4 volts
                record_data                       # record data when event happens
                nextstep
        end
   tmp = step_time
   charge_time = tmp                              # update total seconds of time charging in this step
   charge1_time = tmp/60                          # update screen display in mins.
end
#----------------------------------------------------------------------------


#                      < start clamp charge >                                                              <step #7>

+10000w +chg_C1 a +chg_vlimit v                           # 398.4v clamp to 1.5A or 2.5 hours
   sample_interval = 60                                   # one point a minute
   step_status = ' 398.4 Volt clamp to 1.5A or 2.5 hours total '
        if charge1_time >= 150 then                       # if 2.5 hours accrues in minutes
                net_amp_flag = 0                          # stop adding amp secs
                record_data                               # record data when event happens
                step = charge_rest                        # jump over 50% recharge <step 8>
        end
        if smooth_current <= 1.50 then            # if current drops below 1.50A
                net_amp_flag = 0                  # stop adding amp secs
                record_data                       # record data when event happens
                step = charge_rest                # jump over 50% recharge <step 8>
        end
  tmp = step_time
  charge1_time = (charge_time + tmp)/60    # update total charge time in minutes
end
#------------------------------------------------------------------------------
```

Safety first



Safety first

What to monitor?



Safety first

What to monitor?

1. **Voltage**
2. **Current**
3. **Temperature**

Safety first

Other values to monitor?

1. Negative voltage swing during charge
2. Positive voltage swing during discharge
3. Abnormal voltage during rest
4. Ambient temperature change (Environmental Chamber)

Safety first

Other values to monitor?

6	Rest					Step Time	=	00:00:01	008			ANNN	
7	Pause												
8	Charge	Current	20.0	Voltage	14.7	Voltage	>=	14.6	010	Step Time	00:01:00	ANNN	Constant current charge
						Step Time		02:00:00	010				
						Voltage	-	0.3	007				
						Thermocouple	>=	1 / 40.0	007				
						Thermocouple	>=	2 / 33.0	007				
						Voltage	<=	10.0	007				
						Thermocouple	<=	1 / 20.0	007				
						Thermocouple	<=	2 / 37.0	007				
9	Pause												
10	Charge	Voltage	14.6	Current	20.0	Current	<=	0.25	012	Step Time	00:01:00	ANYN	Taper charge
						Step Time	=	01:30:00	012				

Safety first

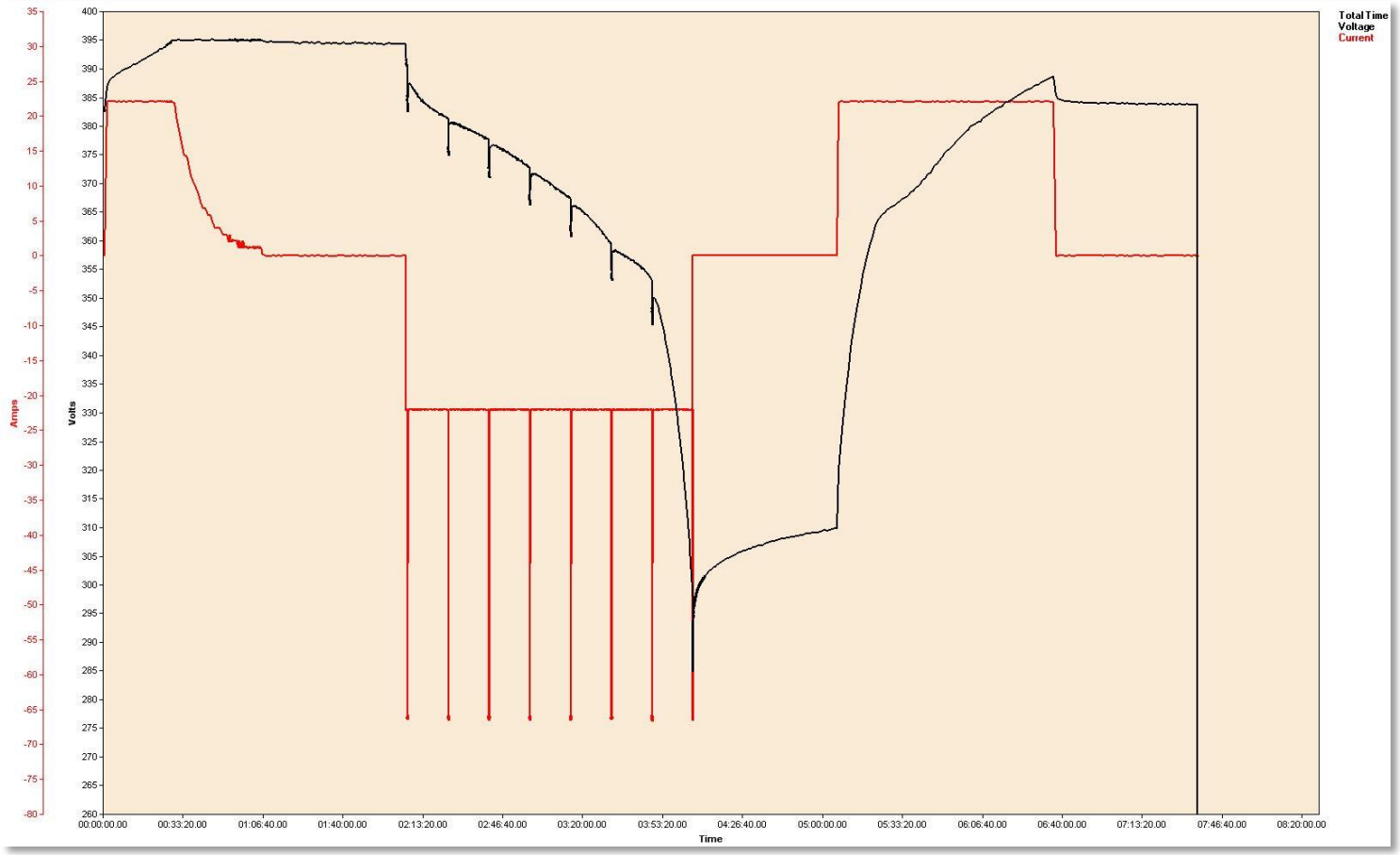
Lessons Learned

1. **Tester malfunctions, including; “hung” bricks, and malfunctioning environmental chambers**
2. **All tests are 100% peer reviewed by qualified test engineer**

**

Function

Typical Peak Power test



Function

Steps necessary to perform test? (Obvious?)

- **The steps actually used in the test are sometimes far more complicated than the written instructions for the test indicate.**

Function

Steps necessary to perform test?

- Error Recovery?
  - Worth Recovery?

Function

Steps necessary to perform test?

- **Error Recovery?**

6	Rest					Step Time	=	00:00:01	008			ANNN	
7	Pause												
8	Charge	Current	20.0	Voltage	14.7	Voltage	>=	14.6	010	Step Time	00:01:00	ANNN	Constant current charge
						Step Time	=	02:00:00	010				
						Voltage		0.3	007				
						Thermocouple	>=	1 / 40.0	007				
						Thermocouple	>=	2 / 33.0	007				
						Voltage	<=	10.0	007				
						Thermocouple	<=	1 / 20.0	007				
						Thermocouple	<=	2 / 37.0	007				
9	Pause												
10	Charge	Voltage	14.6	Current	20.0	Current	<=	0.25	012	Step Time	00:01:00	ANYN	Taper charge
						Step Time	=	01:30:00	012				

Function

Steps necessary to perform test?

- Error Recovery?
  - Worth Recovery?
- Sub-routines
  - Data Management
  - Routine functions, ease of editing

Function

Steps necessary to perform test?

- Error Recovery?
  - Worth Recovery?
- Sub-routines
  - Data Management
  - Routine functions, ease of editing
- Variables
  - Allows standardized tests to be used with minimal editing
  - Decreases likelihood of programming errors

Function

Steps necessary to perform test?

- **Variable Assignments**

VAR1	=	V min	=	1V	
VAR2	=	V max	=	5V	
VAR3	=	C1	=	5A	
VAR4	=	I cutoff	=	0.5A	Current value that ends CV charge
VAR5	=	CC charge sec	=	10800 sec	(3 Hrs)
VAR6	=	CV charge sec	=	7200 sec	(2 Hrs)
VAR7	=	T min	=	27 C	
VAR8	=	T max	=	40 C	
VAR9	=	Rate divisor	=	1	(1=C1, 3=C/3, x=C/x) for loop 1
VAR10	=	Rate divisor	=	1	(3=C/3, x=C/x) for loop 2. A value of 1 will skip this loop
VAR11	=	Rate divisor	=	1	(3=C/3, x=C/x) for loop 3. A value of 1 will skip this loop

Function

Steps necessary to perform test?

- **Variable Assignments**

VAR1	=	V min	=	1V	
VAR2	=	V max	=	5V	
VAR3	=	C1	=	5A	
VAR4	=	I cutoff	=	0.5A	Current value that ends CV charge
VAR5	=	CC charge sec	=	10800 sec	(3 Hrs)
VAR6	=	CV charge sec	=	7200 sec	(2 Hrs)
VAR7	=	T min	=	27 C	
VAR8	=	T max	=	40 C	
VAR9	=	Rate divisor	=	1	(1=C1, 3=C/3, x=C/x) for loop 1
VAR10	=	Rate divisor	=	1	(3=C/3, x=C/x) for loop 2. A value of 1 will skip this loop
VAR11	=	Rate divisor	=	1	(3=C/3, x=C/x) for loop 3. A value of 1 will skip this loop

Function

Variable usage

Step	Type	Mode	Value	Limit	Value	End Type	Op	Value	Goto	Report Type	Value	Options	Step Note (80 character maximum)
1	Rest					Step Time	=	00:00:10	002	Step Time	00:00:01	ANNN	Set volts and current
										Set Variable	atEnd: VAR1=1		
										Set Variable	atEnd: VAR2=5		
										Set Variable	atEnd: VAR3=5		
										Set Variable	atEnd: VAR4=0.5		
2	Rest					Step Time	=	00:00:10	003	Step Time	00:00:01	ANNN	Set times and temps
										Set Variable	atEnd: VAR5=10800		
										Set Variable	atEnd: VAR6=7200		
										Set Variable	atEnd: VAR7=27		
										Set Variable	atEnd: VAR8=40		
										Set Variable	atEnd: VAR9=1		
3	Rest					Function	:	AUXT1>=VAR7	004			ANNN	temp correct?
4	Rest					Function	:	AUXT1<=VAR8	005			ANNN	temp correct?
5	Do1												
6	Advance Cycle												
7	Rest					Step Time	=	00:00:01	009			ANNN	
8	Pause												
9	Chg Func	Current	1.0|VAR3	Voltage	1.0|VAR2+0.3	Function	:	VOLT>=VAR2	011	Step Time	00:01:00	4NNN	Constant current
						Function	:	STIME=VAR5	011				
						Function	:	VOLT<=VAR1	008				
						Function	:	VOLT>=VAR2+0.3	008				
						Function	:	AUXT1<=VAR7	008				
						Function	:	AUXT1>=VAR8	008				
						Voltage	-	0.3	008				

Data quality

CSV Data file

Today''s Date 12/11/2014 9:54
Date of Test: 12/8/2014 16:00

Rec#	Cyc#	Step	TestTime	StepTime	Amp-hr	Watt-hr	Amps	Volts	State	ES	DPt Time	ACR	Temp 1	VARx1
1	0	1	0	0	0	0	0	3.7861	R	0	12/8/2014 16:00	0	29.785	0
2	0	1	0	0	0	0	0	3.7862	R	0	12/8/2014 16:38	0	29.995	0
3	0	1	0.0168	0.0168	0	0	0	3.7861	R	1	12/8/2014 16:38	0	29.995	0
4	0	1	0.0337	0.0337	0	0	0	3.7861	R	1	12/8/2014 16:38	0	29.995	0
5	0	1	0.0505	0.0505	0	0	0	3.7861	R	1	12/8/2014 16:38	0	29.995	0
6	0	1	0.0673	0.0673	0	0	0	3.7861	R	1	12/8/2014 16:38	0	29.995	0
7	0	1	0.0833	0.0833	0	0	0	3.7861	R	129	12/8/2014 16:38	0	29.995	0
8	0	2	0.0835	0.0002	0	0	0	3.7864	R	0	12/8/2014 16:38	0	29.995	0
9	0	2	0.0875	0.0042	0	0	0	3.7861	R	158	12/8/2014 16:38	0	29.995	0
10	0	3	0.0877	0.0002	0	0	0	3.7864	R	0	12/8/2014 16:38	0	29.995	0
11	0	3	0.1075	0.02	0	0	0	3.7862	R	158	12/8/2014 16:38	0	30.011	0
12	0	4	0.1077	0.0002	0	0	0	3.7864	R	0	12/8/2014 16:38	0	30.011	0
13	0	4	0.1243	0.0168	0	0	0	3.7862	R	1	12/8/2014 16:38	0	29.995	0
14	0	4	0.141	0.0335	0	0	0	3.7862	R	1	12/8/2014 16:38	0	30.011	0
15	0	4	0.1577	0.0502	0	0	0	3.7862	R	1	12/8/2014 16:38	0	30.011	0
16	0	4	0.1743	0.0668	0	0	0	3.7861	R	1	12/8/2014 16:38	0	30.011	0
17	0	4	0.191	0.0835	0	0	0	3.7861	R	1	12/8/2014 16:38	0	30.011	0
18	0	4	0.2077	0.1002	0	0	0	3.7861	R	1	12/8/2014 16:38	0	30.011	0
19	0	4	0.2243	0.1168	0	0	0	3.7862	R	1	12/8/2014 16:38	0	30.011	0
20	0	4	0.241	0.1335	0	0	0	3.7862	R	1	12/8/2014 16:38	0	30.011	0

Data quality

Resolution of information needed?

- **Amplitudes (Tester selection)**
  - a) **10A or 10mA**

- **Temporal (data rate)**
  - a) **1 hour or 1 second**
  - b) **General – 10 points**

Data quality

Type of test?

1. HPPC
2. Cycle Life
3. Calendar Life

Type of Step?

1. Pulse
2. Long

Special Needs?

1. End of Step close to limits?

Data quality

Final File Size:

1. **Short duration test**
   i. **Ex. 1 day one second data might be ok**

2. **Long duration, (32 days) only sporadic data**
   i. **One data set beginning and end, some in the middle.**
   ii. **Use Sub-routines to breakout data vs. non-data sets.**

Data quality

- **Data Integrity is Second ONLY to Safety**

- **High quality data enhances feedback to the manufacturer for more efficient product development**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